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I R E A P S

NAVY COMPUTER-AIDED SHIP DESIGN

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ABSTRACT

The Navy efforts in computer-aided ship design and construction have undergone a number of changes in the past two years. The history of these changes is presented, current efforts are defined, and future thrusts are outlined. This discussion includes the Computer Aided Ship Design and Construction (CASDAC) program, the Computer Supported Design program, the Manufacturing Technology program, and the Shipbuilding Technology program. The primary emphasis in describing current efforts and future thrusts is on NAVSEA's computer-aided ship design and the two-way interface of the Navy contract design package with the shipbuilder.

History

The Navy program for applying CAD/CAM technology to ship design and construction has undergone a number of changes in the past few years. To clarify these changes and their relationships, a summary of the history is required as shown in Figure 1.

The Naval Sea Systems Command established a computer-aided ship design group in 1952, one year after delivery of the first commercial computer. All of their efforts focused on applying computers to the ship design phases performed by NAVSEA. Based on the success of these efforts, NAVSEA established a program called CASDAC (Computer Aided Ship Design and Construction) in 1966. The objectives of CASDAC were to prove the feasibility of computer application, to verify the benefits, and to foster the use of computers to all phases of ship design and construction.

In 1980, this program was renamed the CAD/CAM Program. In 1981, the Navy split the program into two separate but coordinated programs. The "CAM" of "CAD/CAM" became part of a larger effort aimed at the private shipbuilding industry. That program is the shipbuilding Technology Program which in turn is a major segment of the Navy's Manufacturing Technology Program.

The "CAD" of CAD/CAM is now called the Computer Supported Design or CSD Program. The remainder of this paper will apply only to the CSD Program.

Computer Supported Design Program

Scope

The CSD Program addresses the need for and application of computer-aided design technology to the design phases performed by NAVSEA with the assistance of ship design firms. In the current NAVSEA ship design process, this includes all ship design phases through contract design as shown in Figure 2. This consists of two types of design; exploratory design and acquisition design. Exploratory design is aimed at defining future ship concepts and assessing the ship impact of developments in ship system technologies. As such, these design efforts are geared to supporting decisions in the development of technology as applied to future ships. Acquisition design is aimed at the design of ships for the Fleet in response to the needs of the Chief of Naval Operations. Acquisition design consists of four stages; feasibility studies, preliminary design, contract design, and detail design. Feasibility designs are executed in close coordination with the Office of the Chief of Naval Operations (CNO) to define the required characteristics of each new ship class that meet the performance requirements and cost constraints.

Preliminary design develops the design to a level required to produce a budget quality cost estimate.

The purpose of contract design is to perform the engineering development of the preliminary design and to produce the specifications and drawings on which the shipbuilders can base their bids.

Following award of the shipbuilding contract, the Shipbuilder performs detail design and construction. Detail design completes the engineering of the ship and tailors the design to the construction facilities and practices of the shipyard. Detail design and construction are overlapped to speed delivery of the ship. The risk of parallel design and construction is significant. NAVSEA design practice has been of sufficiently high quality to make the risk sensible. Both the Navy and the Shipbuilder place great reliance upon the completeness and correctness of the NAVSEA Contract Design Package.

Need

NAVSEA faces a number of challenges in performing ship design. These include:

- * The need for improved engineering capability to design capable and affordable ships. Existing engineering techniques are no longer adequate for the complexity of today's naval ships and the constraints of design-to-cost.
- * The need to respond to CNO in a timely manner,
- * The projected increase in ship design workload.
- * NAVSEA's manpower restrictions.

Given these CNO requirements and constraints, NAVSEA must substantially improve the quality and productivity of its ship

design capability. A major part of **NAVSEA's** attack of this problem is to enhance the technical capabilities of the ship design engineers with the computational and data management power of the computer.

Objective

The objective of the Computer Supported Design (CSD) Program is to improve NAVSEA's ship design capability by providing a computer-based system of design tools. NAVSEA cannot perform ship design or fleet support today without the existing tools built by the CSD Program. With the increased demands **of CND**, a complete CSD Program is required. The **CSD** Program performs total life cycle management of the computer-based ship design system. This consists of the developments procurements and operational support of the computer programs, databases, and computer equipment which form the CSD system. Particular attention is being placed on the design areas such as spacer weight, manning, and combat system performance that drive ship cost and performance.

Current Efforts

The CSD Program has been conducting a major planning effort to define a computer-aided ship design system that meets all the needs of NAVSEA. The near term focus is on surface ship design to suit the workload projected by the Five Year Defense Plan. The longer range includes submarines, non-conventional ship types, and ships built to commercial standards.

To provide the total computer-aided ship design system needed by NAVSEA, the CSD Program addresses nine thrust areas:

- * Architecture - The blueprint of the CSD system.
- * Design Information - Development and maintenance of the central **databases**.
- & Design Applications - Development and maintenance **of the** application programs for the individual design disciplines.
- * Utilities - Development and maintenance of common applications and software libraries-
- * Computer Systems - Acquisition and **support** of the required computer hardware.
- * Facilities - Modifications of NAVSEA facilities to handle CSD.
- * Training - Training of users, management, and project personnel.

- * Project Management - Management of the development and maintenance of CSD.

- * Technology Transfer - The dissemination of CSD products.

Of primary interest are the design applications and design information areas. The design applications are divided into four engineering subsystems:

Ship Design - feasibility studies

Hull - Preliminary and contract design

Machinery - preliminary and contract design

Combat Systems - preliminary and contract design

CSD is not proposing the development of an automated system. The design engineer provides the core of the system using the computer as an aid in the design process. Organizational units retain control of their cognizant data through controlled access and release of their ship design data in a manner similar to drawing approval and release. The CSD concept must reflect both the NAVSEA organizational requirements and the technical requirements of a major computer based system.

Figure 3 illustrates the CSD system concept. The engineer identifies himself, the design to be worked on, and the task to be performed. If the engineer is validated, the appropriate application program is selected which, in turn, defines the required datasets. For the design requested, the appropriate datasets are gathered from the engineer's private datasets, released datasets from other engineers, or approved (baseline) datasets. The program is then executed and the results added as private datasets. If desired, the engineer can release the datasets for review by other engineers and management approval to become new baseline descriptions. The key feature of this concept is the lack of the single, massive, master database containing the total description of the ship from which everyone works. Given the engineering design process attuned to drawing issues, the multitude of designs generated, and hardware restrictions, the dispersed database better meets the needs of NAVSEA. At the same time, it allows a **more** evolutionary, incremental approach that makes use of existing programs.

Parallel with this planning efforts the development of individual application programs has continued. Two of these, HULSTRX and the Design File Manager, are described in separate IREAPS 82 papers. These programs plus HULGEN and HULDEF for hull form design and DEKOUT and GENARR for general arrangements form the ship geometry design package of CSD as shown in Figure 4.

In addition, current CSD efforts include the establishment of standards. The NASA IPAD RIM (Relational Information Manager) has been selected as the standard database management system for CSD and is currently being evaluated. A standard drafting system will

be selected in FY 83 as well as standard graphics interface package for application programs. A software development **specification** for CSD is being completed invoking FORTRAN 77 (ANSI X3.9-1978, full set). **These** standards form the basis for all future development.

One aspect of CSD that might be **dropped** is technology transfer. **The** CSD Program currently disseminates about 400 copies of programs per year to industry, universities, and other government agencies. **The** dissemination of Navy computer programs is not essential to the objectives of the program. The **ship design** agents and shipyards that support NAVSEA acquisition design will be required to perform their tasks using CSD programs on CSD **hardware**. **In view of** the resources required for dissemination, **this** service to the marine industry is **being** critically **reviewed by** NAVSEA.

Future Outlook

The future will see the continued development of CSD applications and the other thrust areas. In keeping with the **evolutionary approach** of CSD, completion of **each** of these will make a small increment towards completion of the full CSD design capability.

However, **the sum of these** increments will mean that the entire contract design package will be computer-generated. It is in the best interests of the Navy and the shipbuilding industry that this information be transferrable to the Shipbuilder in computer-sensible as well as **hard-copy** form. **This is being** done today for the Ship Specification. An increased exchange is currently being investigated for the DOG 51 as a result of producibility studies conducted by shipyards. The use of the Interim Geometry Exchange Specification (IGES) **foras** the leading candidate for **an** exchange format. An IGES interface will be added to the NAVSEA in-house drafting system, IDS, in **FY 83**. There is also a need for the return of design information to NAVSEA for its review role **during** construction and "as-built" information to fleet support the thirty plus **years of NAVSEA** support of the ship.

Conclusion

This **paper** has reviewed the **history** of the Navy's computer-aided ship design efforts⁹ summarized the current efforts, **and highlighted** future directions of the effort. It has also indicated where interfaces need to be addressed between the NAVSEA efforts and the private shipbuilding industry- **NAVSEA is making** progress on meeting the objectives of its computer-aided **ship design program**; to increase the productivity **and** excellence of its ship design organization.

HISTORY

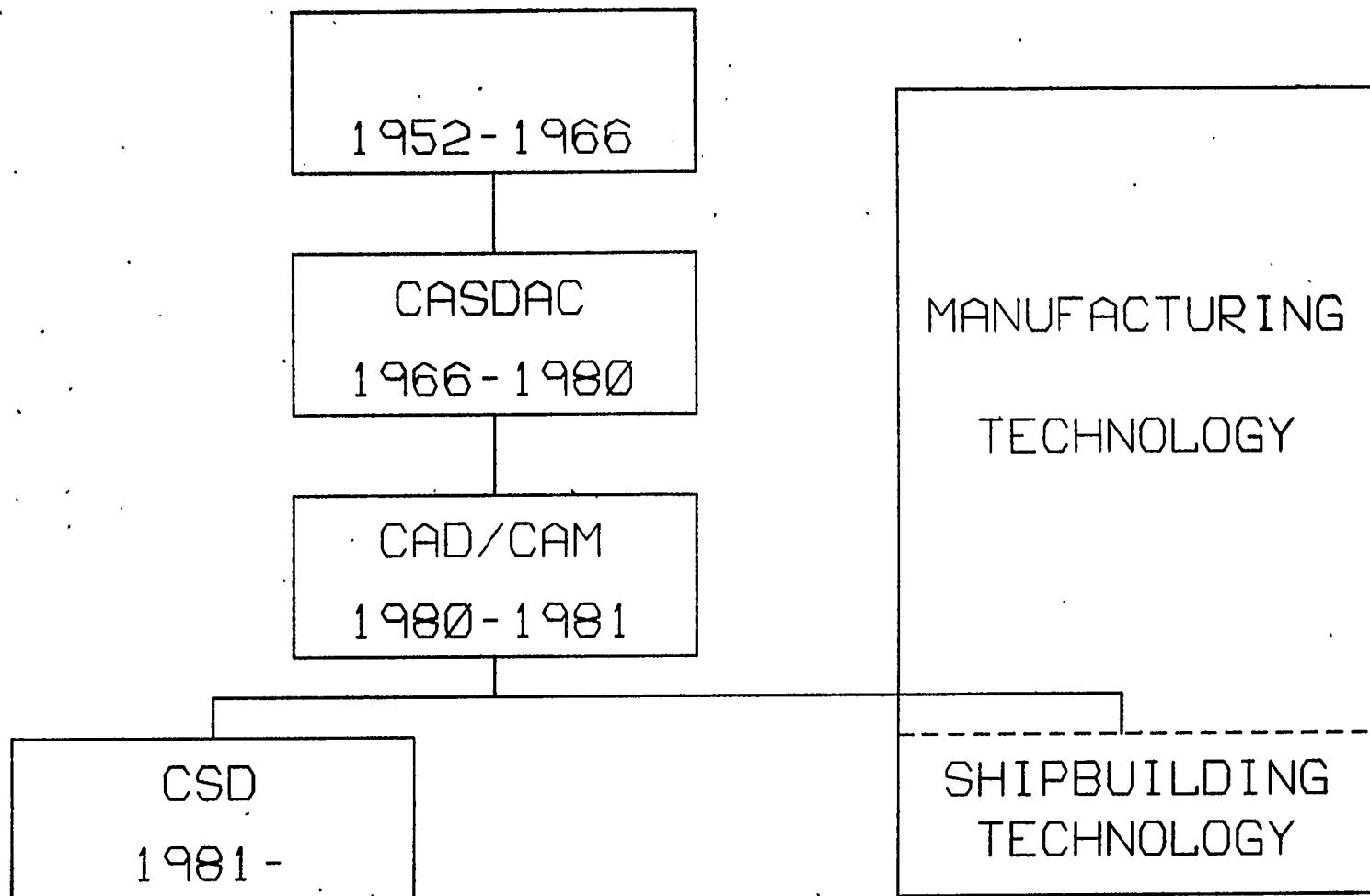


FIGURE 1 HISTORY

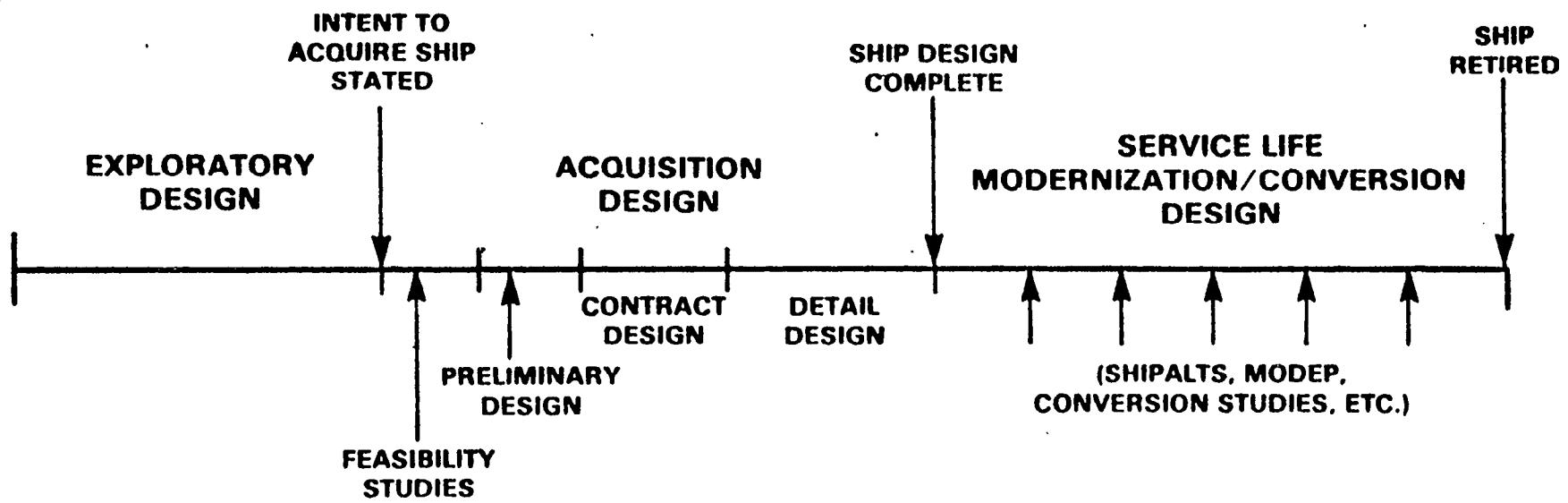


Figure 2 SHIP DESIGN PROCESS

CSD SYSTEM CONCEPT

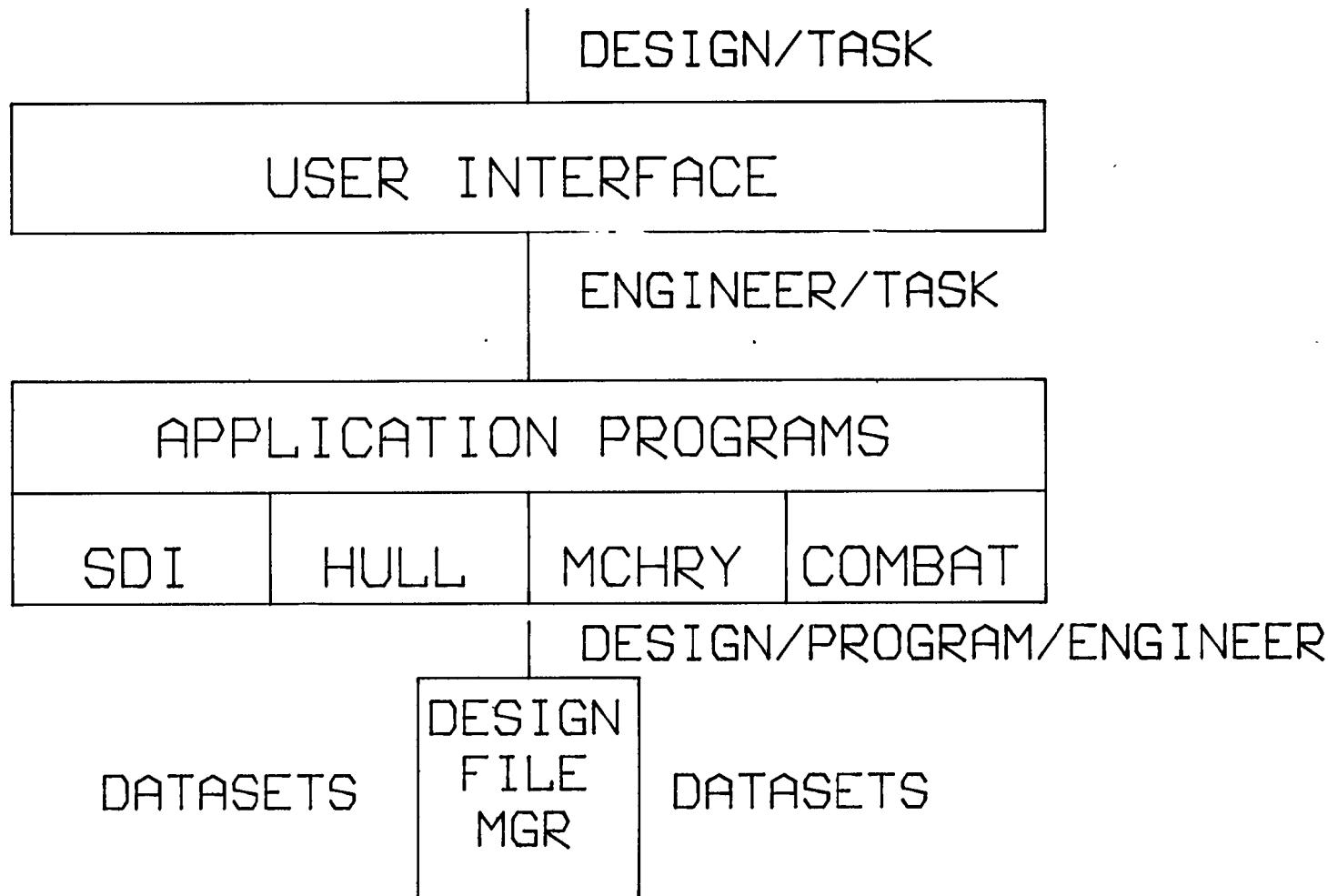


FIGURE 3 CSD SYSTEM CONCEPT

SHIP CONFIGURATION DESIGN

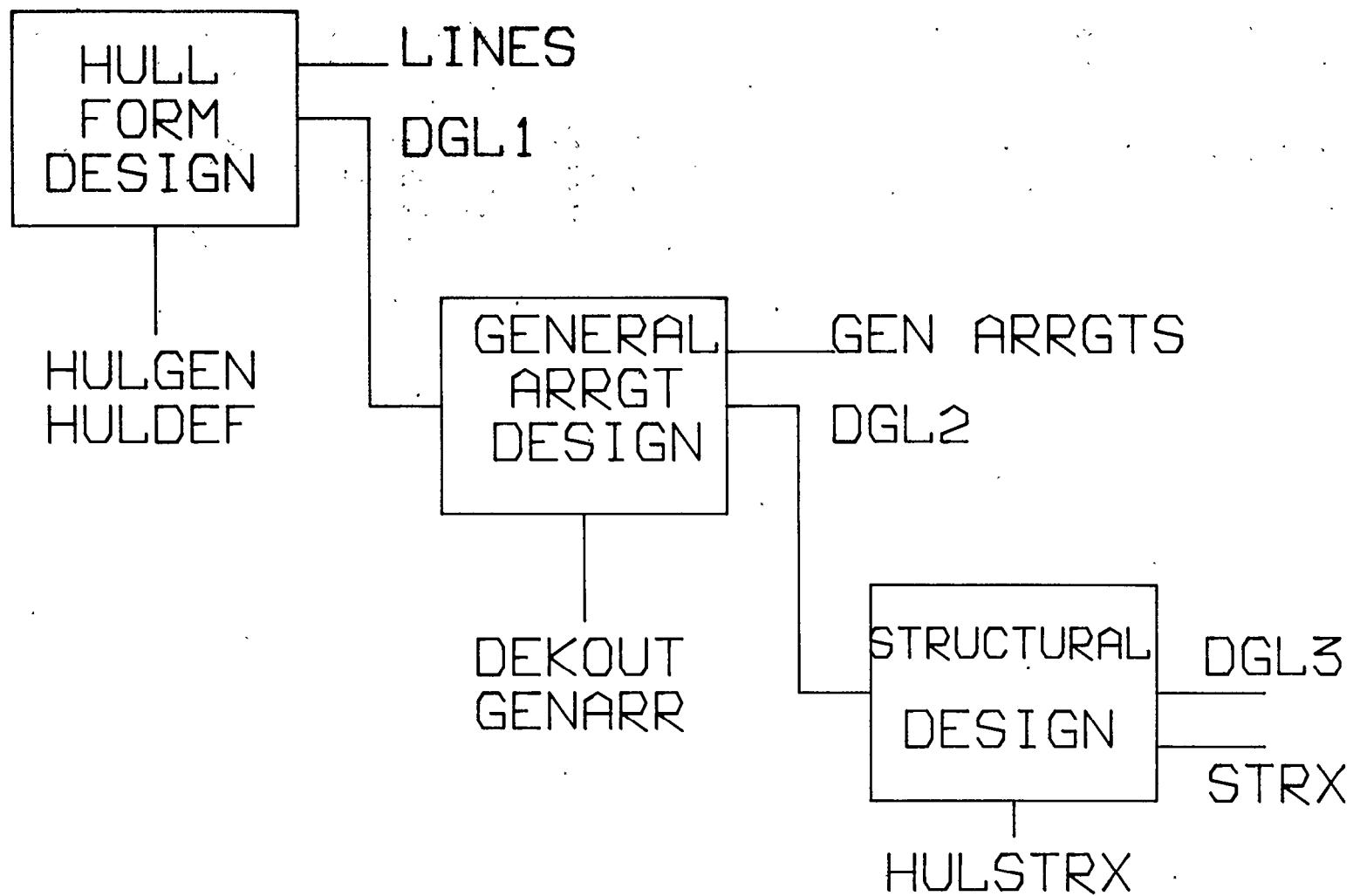


FIGURE 4 SHIP CONFIGURATION DESIGN

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